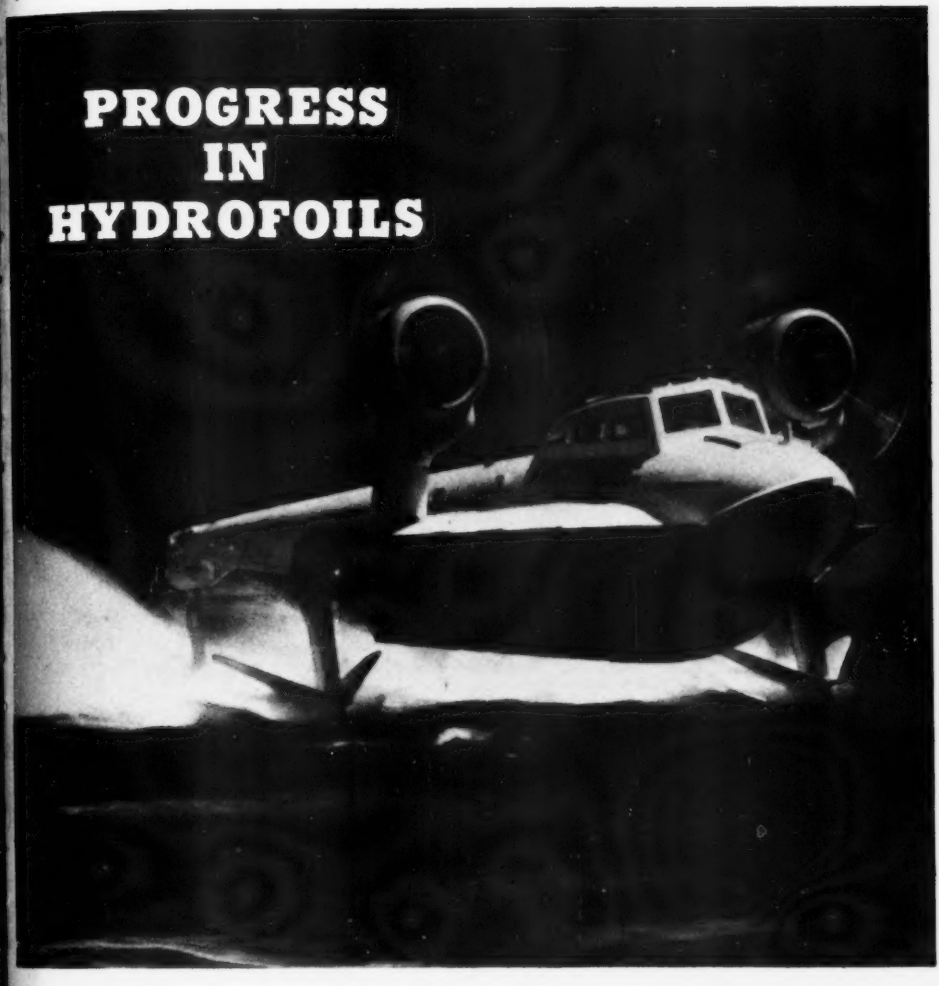
OF MICHIGAN
1956
ENGINEERING
LIBRARY

OFFICE OF NAVAL RESEARCH MARCH 1956

RESEARCH REVIEWS



NAVEXOS P-510

DEPARTMENT OF THE NAVY
WASHINGTON, D. C.

COVER PHOTO: A Navy experimental hydrofoil craft "flying" in the open sea. Shown are fixed foils of the ladder type, and the use of air screws represents one solution to the knotty problem of power transmission. The current state of hydrofoil development is summarized on Pages 1 to 8.

Research Reviews endeavors to report briefly highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. Articles which meet these broad criteria and possess a good degree of readability are welcomed. Manuscripts and changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C.

Research Reviews is listed for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Subscription price: $1.50 per year in U.S. and Canada; $2.00 per year, foreign; $.15 per individual copy.

Approved by Bureau of the Budget, 28 February 1955

DEPOSITED BY THE
UNITED STATES OF AMERICA

In This Issue

Riding High - The Hydrofoil Story . . . . . R. E. Apple

Hydrofoil craft are boats on stilts, supported by winged-feet that "fly" in the water. The Navy is interested because, ton for ton and horsepower for horsepower, the queer-looking craft go faster and ride smoother in a choppy sea. **1**

Some Aspects of the Physics of Viruses . . . . E. Pollard

A biophysicist finds the study of viruses an engrossing challenge, for many of the secrets of human life, including heredity, are locked in organisms whose dimensions--like viruses'--are measured in hundred-millionths of a centimeter. **9**

Radiological Safety at NRL . . . . . L. F. Garcia

Up-to-date knowledge of Health Physics, integrated and carefully applied at a large laboratory, affords a maximum of safety to people who have to work with hazardous radiation. **15**

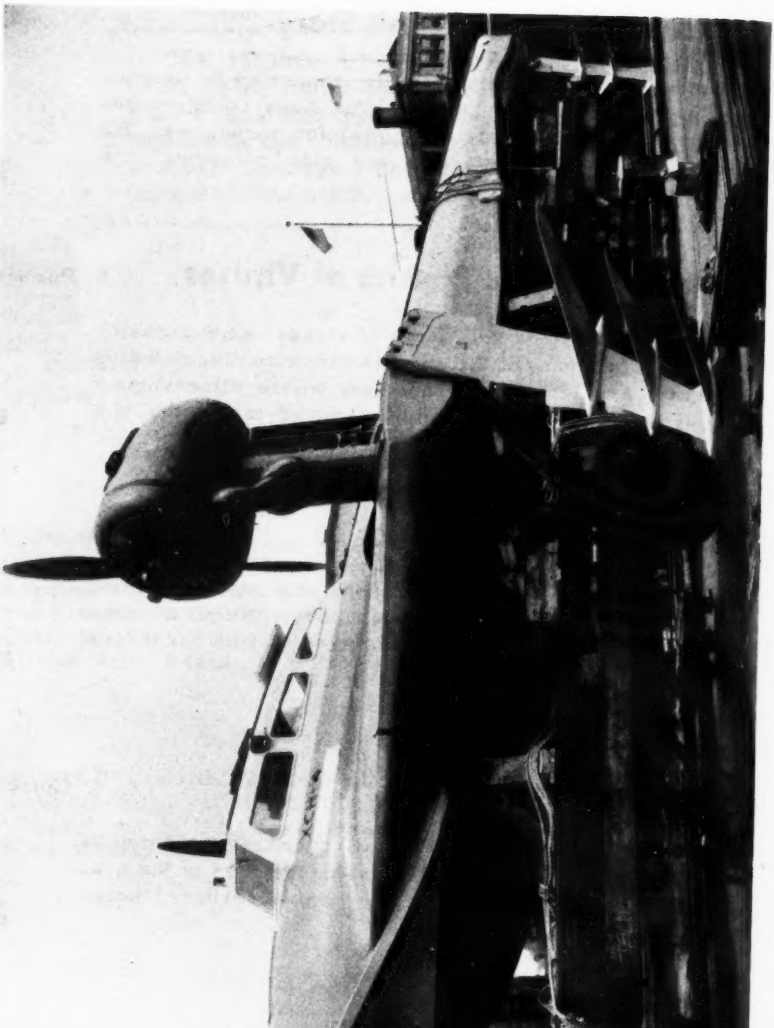
World Symposium on Applied Solar Energy . . . . . R. E. Gomory

Last summer, scientists from all over the world met in Arizona to discuss ways of harnessing the rays of the sun. Among the more promising are heat absorbers, solar furnaces, and solar batteries. **21**

Research Notes

Motion picture on Naval Medical Research. . .Stanford's 550-Mev Accelerator. . . The Age of Icebergs. . .Low-Cost Detector Measures Fallout. . .Scientific Personnel Resources. **25**

On The Naval Research Reserves **28**



The ladder-type foil is a feature of the Carl Boat XCH-4

Riding High — the Hydrofoil Story

LCDR R. E. Apple, USN
Hydrofoil Project Officer
Office of Naval Research

A hydrofoil craft is a boat which proceeds with the hull completely clear of the water due to the dynamic lift of foils which are immersed in the water.

The subject very definitely is not new. Patents exist which are dated before the beginning of the century. In this country CAPT H. C. Richardson, USN (Ret.) successfully flew a hydrofoil boat in 1908. Alexander Graham Bell attained a speed of 60 knots with a hydrofoil boat in 1919, and A. Guidoni in Italy was completely successful in equipping seaplanes with hydrofoils from 1911 to 1918. The Office of Naval Research, actively supported by the Bureau of Ships and the Bureau of Aeronautics, has conducted a research program on hydrofoils and hydrofoil-supported craft since 1947.

A foil can be defined as a surface which produces lift when it is immersed in a moving fluid. The airfoil, such as the wing of an aircraft, produces lift in air, while the hydrofoil produces lift in water. A foil is most efficient when the fluid flows over both the upper and lower surfaces of the foil, since a significant portion of the total lift results from the negative pressure developed on the upper surface. Foil action is different from planing action in this respect; in fact planing can be considered as the degenerate case of flying.

This similarity between hydrofoil and airfoil phenomena may serve to explain, in part, why there was a time lag of 50 years between initial successful hydrofoil experiments and a concentrated research effort. Virtually all of the people talented in flight phenomena were engaged in the more lucrative and more exciting field of aerial flight. Another major factor which contributed to this time lag is that during the early years of this century nearly all of the emphasis in naval architecture was in the field of large ocean-going ships. However, the mass of airfoil data which has been accumulated over the last half century is directly applicable, with modifications, to hydrofoils.

In figuring on which kind of foil will provide the amount of lift, the naval architect has four factors to consider. These are: coefficient of lift (C_L), the density (ρ) of the fluid in which it is flying, the velocity squared (V^2) of the foil in the medium, and the area (A) of the foil immersed; Lift = $C_L \rho V^2 A$. Since it would be next to impossible to vary the density of the medium, and not always desirable to vary the speed, the researcher has remaining the two variables C_L and A.

Hydrofoil craft are, in fact, divided into two broad categories which reflect those two variables or methods of controlling lift. The first is known as the "area-stabilized" or "surface-piercing" foil. With this type, the area immersed is varied. The second category embraces the "incidence-controlled" foils, because the angle of attack is changed to vary lift in a manner analogous to that of an airplane.

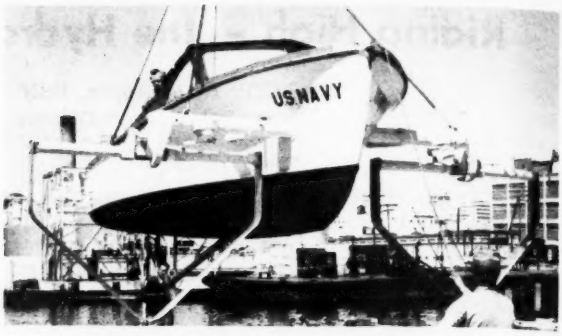


Figure 1 - Boat equipped with Vee foil.

In the first category, the area-stabilized foils, the types which have received the most attention by experimenters in this country, are the Vee foil and the ladder foil.

The Vee foil, as its name implies, is a wing shaped like the letter "V." It corresponds to an airplane wing with a very high dihedral. The apex of the "V" is well beneath the water surface and approximately half of the span extends above the surface. As the foil enters a wave, more of the foil is immersed and additional lift is thus developed to raise the hull up over the wave. Figures 1 and 2 show a 24-foot research craft which uses the Vee foil.

The ladder foil has several individual foil surfaces, arranged like the rungs of a ladder. When a ladder foil enters a wave, additional foil surfaces are submerged and additional lift is developed. A high-speed airscrew-driven hydrofoil craft (Figure 3 and cover photo) uses this configuration.

It is apparent that these area-stabilized foils are inherently stable and no imposed lift control is required. However, a significant percentage of foil span does not continuously produce lift but remains in reserve. If it is considered desirable to reduce the span by allowing the entire foil to produce lift continuously, the foil must be completely submerged. Then an entirely different method must be used; the incidence angle is controlled to control lift. It has been found to be very difficult to control angle of attack manually with a stick as is done

Figure 2 - Test run of Vee foil craft.

in the airplane because of the high rate of encounter with waves at high speeds. Research and development effort has therefore gone into automatic control.

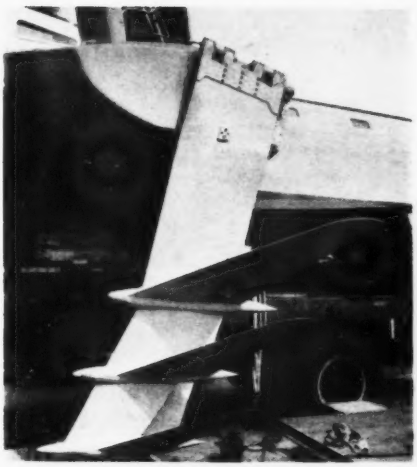


Figure 3 - Construction of ladder foil.

The most simple incidence-controlled configuration is known as the Grunberg, and is named after the French inventor who holds the patent. A Grunberg configured craft has planing skids or skis forward and a submerged foil aft. The angle of incidence of the submerged foil is fixed relative to the boat. As the skids plane over the surface of a wave they increase or decrease the trim of the craft, and the fixed after-foil therefore increases or decreases its angle of attack. This changes the lift aft, and causes the stern to follow but remain clear of the waves.

A somewhat more complicated configuration of incidence-controlled foils has submerged foils fore and aft, and two planing skids forward of the bow. This is known as the Hook configuration, after the English inventor, Christopher Hook. The planing skids do not support any of the weight of the craft. Their function is to actuate the forward foils through mechanical or hydraulic linkages. Thus, as the skids plane up over a wave they increase the angle of the forward foils and lift the bow over the wave. The fixed foil aft increases angle as the craft changes trim and lifts the stern clear of the waves (Figure 4).

Instead of a mechanical sensor, such as the planing skids of the Hook configuration, electrical sensors may be used. Figure 5 illustrates this configuration. As the water level from a wave rises on the two struts located forward on either side of the bow, additional resistances are shorted out. The signal is sent to step-by-step servos which position

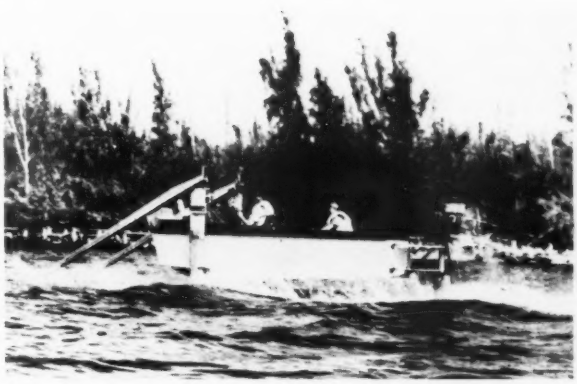


Figure 4 - Test of craft with foil of Hook configuration.

Figure 5 - Foil with electric sensors.

the forward foils. The after-foil can be a fixed Grunberg or it can also be controlled by an electrical probe.

Figure 6 illustrates a configuration that is more completely analogous to an airplane. This craft is controlled by a modified Sperry A-12 automatic pilot which corrects for motion of the craft. The altimeter is a hydrostatic diaphragm well beneath the surface of the water.

The Navy's experience in operating these and other research craft has definitely established the feasibility of hydrofoils. The experimental program has made possible the evolution of design procedures to the point where they can be incorporated into handbooks that allow the naval architect to design small craft, up to about 50 tons, with confidence.

Since a hydrofoil boat proceeds with the hull completely clear of the water, its drag is greatly reduced. As a result, a hydrofoil craft can attain the same speed as a similar displacement boat, with as little as half the horsepower of the displacement boat. This statement assumes the displacement craft has a relatively large speed-length ratio as, for example, crash boats or P.T. boats. If it is desired to use the hydrofoil advantage to obtain added speed, the speed can be increased by as much as 80 percent, with no increase in horsepower.

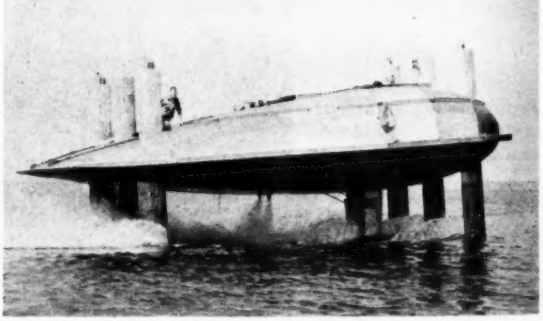


Figure 6 - Hydrofoil craft with design analogous to airplane.

The craft called "Highpockets," which was illustrated in Figure 2, attains a speed of 20 knots as a displacement boat powered by a 125-hp Chrysler Crown engine. As a hydrofoil boat, it can attain a speed of 36 knots. Furthermore, this craft on hydrofoils can make 32 knots in waves as high as four feet. This illustrates the other primary advantage of hydrofoil boats: their speed and riding qualities are vastly superior in rough water to those of either a displacement or planing craft. "Highpockets" has outrun a 63-foot air-sea rescue boat, with the same rated speed, in five-foot swells on the open ocean off Pensacola, Florida. A 25-knot 40-foot air-sea rescue boat could not stay with the 25-knot 16-foot hydrofoil boat, illustrated in Figure 4, in a bad four-foot chop off Miami Beach.

Some of the other advantages of hydrofoil craft are a negligible wake, even at extremely high speeds; lessened rolling and pitching when lying-to in rough water, due to the damping action of the foils; and shallow draft when "flying."

Hydrofoil craft also have some inherent disadvantages. The two principal ones are the increased cost, and the complexity inherent in the foils themselves. It is still not possible to state how serious these factors are since very little operational experience is available and also hydrofoil craft as yet have not been mass produced.

One possible disadvantage which had been foreseen, but which has not yet materialized, is the hazard of the foils hitting an object in the water. If a large timber or other large object were hit, the foil would fold back and cause the boat to brake abruptly. During the Navy's test programs, however, one craft was run aground at full speed without injury to the crew or boat. During one test, the high-speed ladder-foil equipped craft, shown in the cover photo of this issue, inadvertently entered an ice field approximately one-inch thick at 65 mph but was able to complete a turn and withdraw without mishap. Night operations at high speeds in cluttered waters would undoubtedly be difficult.

Although small craft can now be designed with confidence, several major areas still require intensive investigation. Power plants and transmissions constitute a particularly weak spot, and an extensive development effort, perhaps on a national scale, would be required if the need arose for large-scale production of hydrofoil craft. Since hydrofoils develop dynamic lift in a manner similar to airfoils, the initial weight of the craft is as critical as in an airplane. Yet the development efforts in light-weight marine engines have been nowhere near as intensive as have those for aircraft engines. Gasoline engines are sufficiently light to allow a good payload for small craft but present a much greater fire hazard than do the heavier diesels. The gas turbine is one promising development which should contribute to the solution of the engine problem for hydrofoils.

Transmissions are closely allied to the problem of light-weight power plants. Hydrofoil craft present the unique difficulty of transmitting power from the hull through a relatively long distance into the water. The transmissions now being used are of four general types: Vee drives through a long, inclined shaft, a right angle over the stern, high-velocity chain drives through a Vee strut, and air-screw driven. An air-screw drive might be considered a solution to both the weight and transmission problems. A number of considerations combine to

prevent this from being a full answer to the problem, however. Among the chief difficulties are low efficiencies at low speeds and hazards to the crew.

Another broad area which requires additional effort is scaling, especially the scaling of ventilation, cavitation, and seaworthiness. Ventilation is the phenomena of drawing air down the upper, suction side, of a surface-piercing foil. Several methods are now used to inhibit this. One method, widely used in Germany, is to place dams, called "fences," on the foils. These are thin sheets of metal running chordwise placed at intervals along the foil. In this country, ventilation is avoided by carefully choosing foil sections with essentially flat pressure distributions, by using high dihedral on the foil, and by sweeping the foil aft to create a span-wise flow. Although there has been good success in prohibiting ventilation, there has not been equal success in predicting the onset of ventilation when the foil is scaled up. The onset of cavitation also is difficult to predict; however the scaling of model experiments has been fairly reliable.

The scaling of seaworthiness must receive additional attention as larger craft are built. A characteristic parameter which relates lateral stability to the design configuration must be established. Also the limiting wave conditions in which a craft is still capable of sustained flight can not yet be positively predicted from model tests. As an example it was indicated that "Highpockets," in Figure 2, can successfully fly 32 knots in 4-foot waves, but it is not known what are the highest waves in which geometrically similar craft twice this size could fly.

Besides power plants and transmissions, and scaling, additional theoretical and experimental investigations must be conducted on the influence of the water-air interface, in view of the fact that the hydrofoil craft operates very close to the interface of two media.

As an example, the altitude limitations are very severe. An error of one foot in altitude might mean that the boat would broach or crash. Also, as the foil approaches this interface, which is the surface of the water, the lift and drag both change, and the center of pressure shifts. Another complexity which arises from flying near the surface is introduced by the "orbital velocities" of the waves. In an ahead sea they tend to help in that they assist in developing additional lift when it is required to lift over a wave. However, in a following sea the orbital velocities are opposite and tend to decrease the lift when it is desired to develop additional lift over a wave. Also these orbital velocities are not large area disturbances such as air gusts but are local perturbations at each foil. Therefore, each foil must individually cope with its own immediate surroundings. Ideally a foil should continuously allign itself to the orbital flow for steady flight with superimposed angle changes when changing lift.

One question which is nearly always asked is, "How large a hydrofoil boat can be built?" It is still not possible to give a definite answer to this question at the present stage of hydrofoil development. Some insight into the problem can be gained from realizing that the weight of a hull varies approximately as the cube of a linear dimension, but the equation for the lift of a foil relates lift to the square of a foil linear dimension. Therefore foil size grows disproportionately with boat size. This assumes that velocity remains constant. This illustrates the fact

that a hydrofoil craft loses much of its advantage over displacement craft unless the speed is scaled upward as the boat length is increased. A 1000-ton craft would probably have to have a speed requirement of more than 50 knots to be more desirable from a power consideration than a displacement craft of similar size.

The largest craft built to date was an 85-ton tank-carrier built by the Germans during World War II. It ran aground before a complete evaluation was made. This size is probably indicative of present capabilities. It would be necessary to gain experience in the 100-ton size range before proceeding to larger sizes.

Since hydrofoils have been proven feasible for boats of several different sizes and of many different types, the possibilities of numerous naval applications are presented. The Navy's intended operational use of hydrofoils must remain classified, however, until operational prototypes are tested in waters where they can be seen by the general public.

It is possible to discuss a number of commercial applications. There are good indications that hydrofoils will be a success commercially. The 10-ton, 30-passenger boat shown in Figure 7 was designed and built by the German-Swiss firm, Supramar A.G. In operating on Lake Maggiore, Switzerland, from April through the middle of October 1953, it reportedly carried 14,000 fare-paying passengers. In fact when the craft was dry-docked in October for maintenance the company was petitioned to keep it running. This boat was built under the Schertel-Sachsenberg patents. H. F. von Schertel is affiliated with Supramar and G. Sachsenberg's firm is Nautik.

On the strength of the performance of this boat a number of other orders have been received. The Nautik concern of Bremen has built a

Figure 7 - Hydrofoil craft provides passenger service on Swiss lake.

376852 O - 56 - 2

20-ton, 70-passenger boat for operation on Lake Constance, Switzerland. Three-ton hydrofoil police boats have been procured by the French Rhine patrol and the Hessian water police. The Supramar Company has orders for several boats, varying in size from 6 to 20 tons, for use on the Italian Lakes and for the French Rhine patrol. The hydrofoil design sections of both German firms appear to be saturated with work as a result of a steady stream of orders.

The vigorous state of commercial hydrofoil development in Europe is probably due to the relatively greater importance of water routes for inland transportation.

In the United States hydrofoil craft are just beginning to gain a commercial footing. Several small boats are on the market in very limited quantities and it is known that small hydrofoil boats are being displayed in larger quantities at the boat shows. These small craft are being used mostly for sporting purposes. The first application for larger commercial boats will probably be to provide transportation in the off-shore oilfields, and there is some indication that this will begin during 1956.

The other applications developing in Europe such as police and harbor patrol and ferry service will probably eventually develop in this country also, although to a more limited extent.

So far little has been said about the application of hydrofoils for seaplanes. It was indicated early in this paper that A. Guidoni was completely successful in adapting hydrofoils to seaplanes. He stated:

> "Landing a machine in a rough sea is easier. In taking-off no bumps or shocks of any kind are experienced, the machine behaving as if it were supplied with the most efficient shock absorbers. This is to me the most important of the advantages."

However, as seaplanes grew in size and weight and as take-off speed increased, hydrofoil design became increasingly more difficult. The central problems are foil-cavitation, ventilation, and structural strength. Yet the hydrofoil appears to offer certain definite contributions. The two principal advantages are:

- Better lift-to-drag ratios than either the stepped hull or the hydroski,
- Much better rough-water characteristics than the hull, and as good or better rough-water characteristics than the hydroski.

The hydrofoil has not received the research effort over the last ten years that the hydroski or the stepped hull have enjoyed. However, now that additional basic information on the hydrofoil has been collected, a renewed effort is again being made to investigate the feasibility of adapting foils to seaplanes.

In summarizing the hydrofoil picture today, it is possible to state that, after almost 50 dormant years, hydrofoil knowledge has advanced to the stage where small boats can be reliably designed to desired specifications. Also, there is apparently a commercial market for craft with these special characteristics in areas where boat traffic is a necessary mode of transportation. There must be continuing investigation, however, to make the smaller craft more efficient and to progress to larger craft if a requirement is indicated.

Some Aspects of the Physics of Viruses

Dr. Ernest Pollard
Biophysics Laboratory
The Josiah Willard Gibbs Research Laboratories
Yale University

It is worthwhile taking a moment of introduction to say why a physicist should find the study of viruses so interesting. If one looks back at the period of greatest excitement in physics, one sees that these were years of conflict, in which established physical ideas failed to explain a wide range of events. Perhaps the most notable of these occurred around 1914 or so when the new atom of the physicist, the Bohr atom, was tried out against the facts of chemistry. As everyone knows, it failed, and the contrast between the atom of Lewis and Langmuir; the chemists' atom, and the atom of the physicist, was so great that the two seemed irreconcilable. Many of us can recall the amused way in which the picture of electrons held in a stationary pattern around a nucleus was regarded by physicists, and yet this model had a great many elements of truth, including the necessary ones for the explanation of chemical valence.

The conflict was ultimately resolved by Quantum Mechanics, perhaps the greatest advance ever made in physics. Now, in the case of living systems, we have another stage at which conflicts may develop. Are the laws of physics sufficient to explain the facts of living systems, or is some form of new organizational principle necessary? One might think that such a philosophical question is somewhat remote and so without interest, and yet the study of the physics of viruses is already bringing the question into sharp focus, and a decision as to whether physics is adequate or not may well be possible within the next five years. This makes the study of viruses doubly exciting.

To show how a dilemma may develop, consider the interaction between genetics and viruses. Genetics is the precision study of biology, and in it we have learned that the laws of heredity are governed by "linkage groups" which have elements that can be accurately placed in order. This ordering of the genetic elements is possible because of the "crossing-over" phenomenon, which means that there is an interchange between the elements of a chromosome, and this interchange alters the order and so alters the hereditary properties of an organism. By studying the frequency of crossing over, it is possible to tell whether the genes are at the end of a chormosome, far apart from each other, or close together. When one attempts to take these linkage groups and associate them with the length of a chromosome in an organism like corn, or the herb tradescantia, one finds that quite large molecular elements are available for each gene.

The situation is quite otherwise in the study of viruses. Although a virus is a very simple object compared to a plant, nevertheless well-defined hereditary features are known. These concern the kind of host cells on which the virus will grow, or the rapidity with which it will grow, and recognizable characteristics that have been developed.

Furthermore the phenomenon of exchange, between parts of the equivalent of chromosomes, also takes place. Thus linkage groups can be established for viruses, and the position of the genes along these linkage groups can be established.

Now the interesting thing about a virus is that it has a diameter of only about, say, 500 Ångstrom units. Further, not all of this bulk is used in the hereditary substance; some remains outside the cell and takes no part in the effective behavior of the virus. So the hereditary traits have to be placed in a relatively small molecular chain, Recent work by Benzer at Purdue has shown that if one takes everything very literally, the unit which is responsible for a hereditary trait can be confined as being in a space smaller than 6 Å in length. Six ten-millionths of a millimeter is getting down pretty small! Small as it is, Benzer and others are not yet finished, and still finer genetic analysis is possible. If physicists have been able to construct working models of atoms, by inference drawn from meticulous study of the material containing the atoms, they surely can apply similar methods to the study of viruses. It may prove that the relation between the genetic structure of a virus and the physical structure of a virus is incompatible. In any event, whether this is so or not, it is extremely interesting to see the two sciences of genetics and physics coming close together in virus studies, and it is an open question as to whether physics can provide the explanation for genetics or whether genetics will require more than known physical principles.

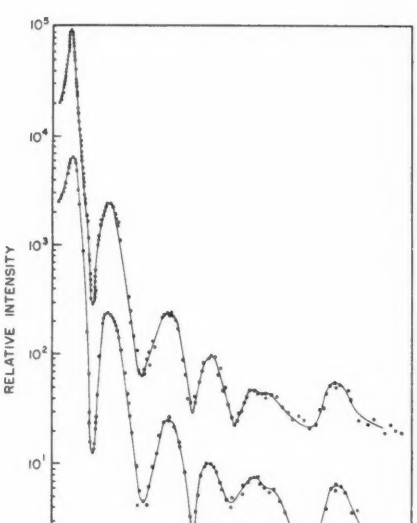


Figure 1 - An X-ray beam produces intensity pattern with maxima and minima that result from interference between separate virus elements.

It is worth while considering what contribution physics can make to this comparison between the genetic pattern and the molecular structure. Quite clearly viruses are desirable organisms to work with, because being so tiny the amount of genetic material is thereby limited. It becomes necessary, however, to find out just how much genetic material there is. Three ways seem to be available by which some idea of the size and shape of genetic material can be obtained.

The first method, which appeals very much to physicists, is the use of structural analysis by X-ray diffraction—shooting X-rays at the stuff and then studying the reflection patterns on the exposed plates. This has perhaps ceased to be a powerful tool for physics itself, but it is of great importance as an applied weapon. It is possible to get

tobacco mosaic virus preparations well oriented and in relatively high concentration. When a good, well-oriented, specimen is used, as many as two thousand individual reflections can be obtained. Pictures such as this have been taken by J. D. Watson and by Rosalind Franklin, and subjected to as good an analysis as has proved possible. In this way Watson has concluded that the outer part of tobacco mosaic virus consists of a helix of elements which are of molecular weight 35,000 and which repeat in pattern every three turns. There are 1200 of these subunits. This helical structure actually is not the whole content of tobacco mosaic virus, nor is it, in all likelihood, the genetic part.

It is much more likely that the ribonucleic acid* is actually the part concerned with the transmission of hereditary information. In order to find out about this, the methods of X-ray scattering can also be used. If the oriented specimen we have just discussed is put in front of a slit X-ray beam, then there is a scattering at various angles which shows maxima and minima. Such patterns are shown in Figure 1, which was provided by Dr. Caspar of the Yale Biophysics Department. These maxima and minima result from interference between the separate virus elements, and the form of the intensity pattern can be calculated if the shape and structure of each element is known. There is a theory that virus rods are simple uniform cylinders, but this does not give the right distribution. If instead, it is supposed that the virus is hollow down the center, with an annular region having a radius of about 55 Å, then the scattering pattern is correctly interpreted. Therefore it seems very likely that the ribonucleic acid, which would scatter X-rays more by reason of its high phosphorus content and consequently high electron density, is actually distributed in some way in the cylindrical center that runs the length of the virus. Clearly this gives a molecular structure which can one day be related to a genetic pattern.

A second method of study of such a virus, in point of fact also of tobacco mosaic virus, has been carried out by the author and Dr. Dimond and also by Mr. Whitmore. We already knew, viz. the first method, how a virus behaved when it was active; now we rendered it inactive—incapable of multiplication—by exposing it to an ionizing radiation. Thus we could study the nature of the particle itself. This technique has many advantages, notably that it does not require very pure preparations, and that it also uses the very sensitive amplifying powers of the virus—its multiplication—for detection.

If a tobacco mosaic virus preparation is placed in the path of a beam of ionizing radiation, for example X-rays or fast electrons or deuterons or alpha particles from cyclotrons, the virus ceases to be infective. This loss of infectivity can be measured by a failure to cause lesions on the leaves of sensitive tobacco plants and can be measured quite quantitatively. Now the loss of ability to infect is statistically related to the energy which is left in the virus particle by the beam. It is possible to relate this to either a sensitive cross section or to a sensitive volume, depending on the character of ionizing radiation. When this is done it is found that the sensitive volume, and

*An acid found in the nucleus, yielding ribose as a product of hydrolysis.

sensitive cross section and actually the total virus sensitivity itself fit very well with a region of radius 50 Å and length 3000 Å. This is very near the figure found, in the first method, for the probable location of the ribonucleic acid in the virus particle.

The long, rod-shaped, form of the virus enables orientation studies to be made. By letting a preparation dry while it is being rocked gently to and fro, one can be made which has definite birefringence (double reflection). If the material is then placed so that the rods are end-on to the deuteron beam of a cyclotron, the observed sensitive cross section is, as would be expected, quite low. If, however, the particles are placed across the beam, thereby exposing the maximum area, the cross section is found to be larger. This was done by the author and Whitmore and constitutes very good evidence that the ionizing radiation really does act on a particle of definite size and shape. Thus this second technique confirms the X-ray observations and again gives a notion of the molecular length of the sensitive part of the virus.

While we have here considered the length of the genetic part, it is very interesting to try to see, by a third method, what the relative sizes of the other parts of a virus are. We know that an animal virus will not only infect, but it can interfere with another virus; it can also cause red blood cells to agglutinate, and it can combine with its own specific antibody. A careful study of influenza virus has been made by the author and Powell, and by Powell and Setlow. Some of their findings are given in the next two figures.

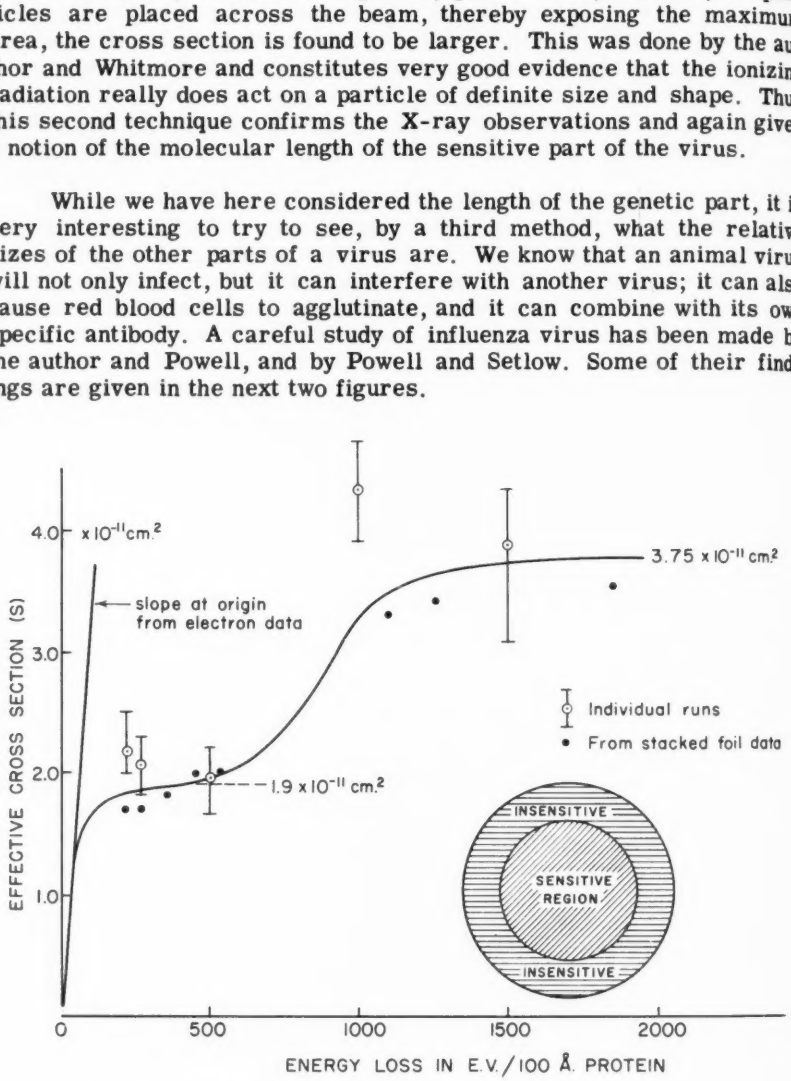


Figure 2 - Influenza virus bombarded with particles shows property of infectivity.

Consider first the property of infectivity on the part of the virus. Studies by the author and Jagger showed that the sensitive cross-section varies with the bombarding particle's energy in a manner indicated in Figure 2. Instead of the sensitive cross section being uniform, two plateaus are obtained corresponding apparently to an internal structure of some kind, one of which is quite sensitive and one of which is very insensitive.

If in place of the infectivity the ability to interfere with another virus is studied, then a somewhat different situation arises, in that a much less sensitive region is seen, requiring more bombardment to inactivate. The figures for cross section and volume fit rather well with a thin spherical shell which occurs somewhere in the inside of the virus. The property of agglutination follows a different pattern and is still smaller and still less sensitive. Finally the property of combining with an antibody would appear to be the smallest of all.

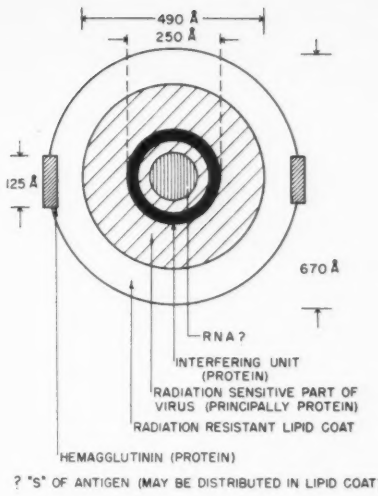


Figure 3 - By combining the research findings on influenza viruses, this type of structure is inferred.

It is usually accepted that the infectious property, which is related to the whole virus property, requires the nucleic acid of the virus to take part in its action. That this is so is shown in studies of the action spectrum for ultraviolet light, taken by Powell and Setlow. It can be seen that the maximum of action occurs at the 2600 Å point and this is to be contrasted with the maximum for interfering ability, which occurs at the 2750 Å point. It would look, therefore, as though interference is a protein-like property, while infectivity as such, has more of a nucleic acid-like property.

All of these can be put together in a figure from Powell, which is shown as Figure 3. This represents an inferred structure for influenza virus which may or may not be right, but which represents a guess at the structure of this animal virus.

In conclusion we can say that these few examples of physical studies of viruses point the way to a very interesting philosophical question as to whether physical laws can work in biological systems, and also show that there is directly going forward a means of measuring the molecular sizes responsible for genetic action, the molecular internal structure of viruses, and that all these, when put together, may or may not require further interpretation outside the known realm of physics today. It is in the expectation of the development of this dilemma that we can pause for the moment, and wait five years for experiment to progress to the point where there is either no dilemma or one of the sharpest kind.

Figure 1 - Radiac meters used in radiological surveys and area monitoring.

Figure 2 - Reading neutron films at microscope and beta-X-gamma films at densitomer.

Radiological Safety at NRL

Luis F. Garcia
Health Physic Unit
Naval Research Laboratory

There are all types of radiation at the Naval Research Laboratory–alpha, beta, gamma, X, thermal neutron and fast neutron. The Laboratory already has several hundred radioactive sources as well as numerous accelerators and X-ray machines, and a nuclear reactor is scheduled to be in operation this summer. In the course of its operations, the Laboratory has on hand radioactive materials which, in curies, add up to a quantity four times greater than all the radium extracted throughout the world in the past 50 years. The radiation hazards are increased by the operation of accelerators which include Van de Graaffs, Cockroft-Waltons, microtrons, a betatron, and a synchrotron.

One of NRL's radioactive sources alone, if unshielded, would, at a distance of one foot, produce a lethal dose in less than 30 seconds. (A median lethal dose is defined as the amount required to kill 50 percent of the individuals in a large group.) Other sources are capable of causing serious injury from brief exposures.

An individual is incapable of sensing radiation, even at dose-rates which can definitely result in deleterious effects. The time delay between exposure and the manifestation of damage may be quite long—25 years or more. In activities where radiation hazards exist, a well organized radiological safety program and qualified persons equipped with proper radiac instruments (Figure 1) and facilities (Figure 2) must be relied upon for the protection of personnel.

NRL RADIOLOGICAL SAFETY PROGRAM

A manual of the NRL Radiological Safety Regulations, authorized by the Director of the Laboratory, is issued to all persons whose work brings them in proximity to radiation hazards. The values for the maximum permissible exposure and maximum permissible contamination are based on AEC regulations, the latest values recommended by the National Committee on Radiation Protection, and those used at large radiation laboratories such as the Oak Ridge National Laboratory. At NRL, the values for maximum permissible exposures are considered as a "ceiling" for guidance only and not as a limit to justify unnecessary exposure. It is Laboratory policy that every effort be made to eliminate all unnecessary exposure to radiation.

The NRL Radiological Safety Organization consists of:

Radiological Safety Committee: This Committee is charged with the formulation of rules and procedures to minimize hazards due to ionizing radiation.

Isotopes Committee: This Committee fulfills one of the AEC requirements for an activity to be eligible for a general authorization for the procurement of radioisotopes.

Radiological Safety Officer: The responsibility for radiological safety is assigned to a single individual—the Radiological Safety Officer. This person must possess a thorough academic and technical training, as well as sufficient practical experience, in the field of radiological physics. The Radiological Officer is a civilian Health Physicist.

Medical Officer: The Medical Officer is responsible for all medical aspects of the Radiological Safety Program as required by current Bureau of Medicine and Surgery directives and Laboratory orders.

Health Physics Unit: This Unit, under the direction of the Radiological Safety Officer, is responsible for the over-all operation and material aspects of the Laboratory's Radiological Safety Program.

HEALTH PHYSICS SERVICES

When a Health Physics Unit serves a large Laboratory much more is involved than simply measuring dose rates with portable radiac meters. Radiological safety problems are as complex and varied as they are numerous. The handling of these problems requires the Health Physics Unit to carry out a multiplicity of specialized services. In order to be able to carry out these services, the Unit must be well organized, trained, and equipped. The problems involve technical, as well as administrative, aspects not only in the fields of science in which the sources of radiation are being used, but also in other fields such as meteorology, geology, sanitation engineering, and public relations.

Of course, the primary function of the Unit is the protection of personnel (Figure 3). In addition, the Unit has been assigned responsibilities aimed at maintaining a low radiation "background" in order to prevent interference with scientific projects involving measurements of extremely low levels of radiation.

At present, the Unit consists of eight members—three of whom have received specialized academic and technical training through AEC Radiological Physics Fellowships. It is divided administratively into three sections: (1) Personnel Monitoring; (2) Radioisotopes and Reactor; and (3) High Voltage and Radiac Calibration.

The Personnel Monitoring Section has the responsibility of supplying and maintaining all of the personnel-monitoring meters and facilities, interpreting the data obtained from these meters, and maintaining complete records of all radiation exposures of personnel. The personnel-monitoring meters used at NRL are of two general types: film badges and pocket meters. Two different types of film are used: DuPont Type 552 for beta, gamma, and X radiation, and Kodak Type NTA for fast-neutron radiation. Supplementary forms of the film badge are the wrist badge and ring meter. Pocket meters are of two types: self-reading dosimeters for X and gamma radiation and non self-reading pocket meters for thermal neutron radiation.

A close liaison between this section and the Medical Officer is maintained in connection with blood counts, eye examinations for radiation cataracts, physical examinations, radiourinalyses and radon breath samples.

Figure 3 - Measuring gamma dose-rates during radio-chemical operation.

It is the responsibility of the Radioisotopes and Reactor Section to carry out the radiological surveys, area monitoring, and radio-assays in connection with radioisotopes and the reactor. By radiological survey is meant the evaluation of the radiation hazards incident to the production, use, or existence of radioactive materials or other sources of radiation under a specific set of conditions. Such evaluation customarily includes a physical survey of the disposition of materials and equipment, measurements or estimates of the levels of radiation that may be involved, and a sufficient knowledge of processes using or affecting these materials to predict hazards resulting from expected or possible changes in materials or equipment. Area monitoring is the routine periodic or continuous determination of the level of radiation or of radioactive contamination of any particular area, building, room, or equipment (Figure 4). Routine area monitoring in a particular area might include any or all of the following:

- Measuring the dose rates from external radiation,
- Checking for possible surface contamination,
- Taking air samples and assaying these to determine the presence and extent of airborne contamination,
- Checking for contamination, waters in which sources are used or stored,
- Measuring the air flow in radiation fume hoods,

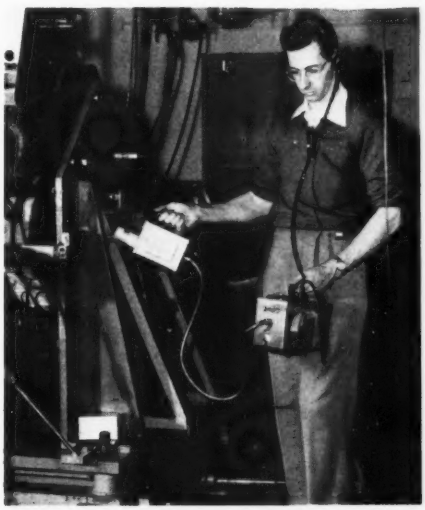


Figure 4 - Measuring neutron radiation for accelerator.

- Taking an inventory of all radioactive sources,
- Testing all sealed radioactive sources for leakage,
- Collecting radioactive waste,
- Measuring background radiation throughout the Laboratory,
- Maintaining records of all the above activities.

Radiological surveys are carried out whenever a new radiological problem arises. Health physics services involved may be any or all of the above-mentioned services as well as before-hand calculations of dose rates, personnel exposure, required shielding, possibility of airborne contamination, and other possible hazards associated with the contemplated procedure.

Contamination is defined as the deposition of radioactive material where it is not desired, and particularly in a place where its presence may be harmful. Personnel exposed to possible contamination are checked with very sensitive portable radiac meters or with AC operated radiac equipment such as hand-and-foot monitors (Figure 5), count-rate meters, and alpha proportional counters. The majority of cases of contamination occur with the person affected unaware or not knowing what is happening even though the level of contamination may be quite high. This is because the physical quantity (mass) of the contaminant is usually

Figure 5 - Checking worker for contamination.

so small it cannot be seen with the naked eye. A contaminant may present both external and internal radiation hazards. Because of the possibility of contamination, people who handle radioactive material must exercise great caution and make a habit of routinely checking their laboratory and their own persons with the radiac meters assigned to them, as often as the situation warrants. In order to prevent the contamination of personnel, Health Physics issues such items as expendable clothing, respirators, gas masks, gloves, and special handling devices.

Figure 6 - Storing dry radioactive waste in concrete vault. Notice sealed vaults.

This section maintains the necessary decontamination equipment and supplies, and supervises the decontamination procedures to assure the safety of personnel and prevent the spreading of the contamination beyond the immediate area. A decontamination building for personnel and equipment is to be built in NRL within a few months. Electrodecontamination facilities for metallic items will be included.

The dry waste collected by the Health Physics unit from the various laboratories is stored in reinforced concrete vaults which are sealed with concrete. Liquid radioactive waste is neutralized or made slightly basic. It is then mixed with cement in 55-gallon metal drums, which are sealed with concrete when nearly full (Figure 6). About once a year, all of the sealed containers of radioactive waste are transferred by NRL trucks to Norfolk, Virginia. Before leaving NRL, each container is weighed (to insure it will sink in sea water), measured for maximum dose rate, checked for contamination, and labelled. When loaded, the truck (especially the cab) is carefully monitored and radiation signs affixed to it. At Norfolk, the vaults are loaded on a Coast Guard vessel specially rigged for handling the radioactive waste. The waste is dumped at a carefully selected spot in the ocean, which is over 100 miles from shore and where the ocean depth exceeds 1000 fathoms. The entire operation is carried out under the supervision of a health physicist.

Turning now to the High Voltage and Radiac Calibration Section, its primary responsibility is to carry out the necessary radiological surveys and area monitoring for all of the accelerators and X-ray units. With some exceptions, the radiological problems involve solely external radiation. Besides the radiations from the beams of the accelerators, there are the radiations resulting from the interactions of the beam with the target or other materials the beam happens to strike. Further, in dealing with accelerators there is also the problem of induced radioactivity.

The measurement of dose and dose rates from accelerators and X-ray units is a highly complex art, which requires a thorough knowledge

of the experimental equipment, the radiation processes involved, and specialized dosimetry. Surveys of the sources of radiation are complicated because of the extremely wide range of radiation energies, by the fact that the radiation may be emitted in pulses, and by the limitations of existing radiac meters for the radiation energies involved. Any one accelerator, or X-ray unit, can be used under various operating conditions; so that it may be considered as being equivalent (in a radiological safety sense) to as many radioactive sources.

For radiation safety one must rely on information obtained with properly calibrated radiac meters. For this reason, the responsibility of this Section in maintaining and calibrating radiac equipment is an exceedingly important one. No matter how well-trained and cautious the experimenter or health physicist is, he cannot properly assess a radiological situation solely on the basis of his senses (which cannot respond to radiation) and theoretical calculations. All portable radiac meters are calibrated in a specially designed and equipped radiac calibration building. Film badges and dosimeters are also calibrated in this building for gamma radiation, and the pocket meters for thermal neutrons. Film badges are calibrated for beta radiation with a natural uranium source. The Kodak NTA film is calibrated in the open with a Po-Be neutron source whose neutron emission is known. Recent improvements at NRL in microscopy techniques enable the technician to read fast neutron doses well below the maximum permissible weekly dose without increasing the reading time for each film. The Health Physics counting-room counters (alpha and beta-gamma) are calibrated for geometry and counting efficiency with standard sources procured from the National Bureau of Standards.

In addition to the above, the Health Physics Unit conducts lectures and special training courses in radiological safety, participates in the Passice Defense Program, and does research and developmental work in the field of Health Physics, specializing in problems peculiar to the Navy. Also, by keeping up with current scientific literature and maintaining a close liaison with radiation laboratories throughout the country, the Unit keeps abreast of current developments in this rapidly expanding field of Health Physics.

Handbook on Wave Forecasting

In the article on Project AROWA (Applied Research; Operational Weather Analysis), that appeared in Research Reviews for January '56, mention was made of a handbook on oceanography being prepared by the Navy Hydrographic Office. Strictly speaking, it is not on oceanography in general, but on wave forecasting. The full title is "Practical Methods for Observing and Forecasting Ocean Waves," by W. J. Pearson, Jr., G. Neumann, and R. W. James. It is HO Publication 603, and may be purchased from the Superintendent of Public Documents (Government Printing Office) or from the Navy Hydrographic Office, Suitland, Md.

World Symposium on Applied Solar Energy

ENS R. E. Gomory
Physical Sciences Division
Office of Naval Research

The solar energy reaching the earth has two main characteristics. There is a lot of it, and it is spread very thin. The first characteristic accounts for the long history of attempts to harness solar energy, while the second has prevented any great successes. The energy provided by the sun amounts to about 2 gram-calories per minute per square centimeter (0.14 watts per square centimeter) on a surface facing the sun and located outside the earth's atmosphere. Due to atmospheric absorption, scattering, and reflection from clouds, less than half of this energy reaches the earth. This supply, although dilute, is still very large. The solar energy falling on the United States each day is nearly 2000 times the daily energy requirement for heat, light, and power.

At the recent World Symposium on Applied Solar Energy, cosponsored by the Office of Naval Research, scientists from many parts of the world gathered in Tucson and Phoenix, Arizona, to discuss advances that may lead to a greater utilization of this energy. Some of the developments discussed at that meeting are described below.

Since solar energy is so widely spread, it is necessary to collect it over a large area to obtain appreciable amounts. This can be done by using either lenses, reflectors, or flat-plate collectors. Large reflectors can be made much more cheaply than large lenses but even reflectors are extremely expensive when it comes to covering large areas of ground. The most widely used system is the flat-plate collector.

A flat-plate collector consists essentially of a large metal plate, blackened for better absorption and placed where the sun can heat it. Water can be run through pipes in contact with the hot absorbing plates, and when heated, can be used as a hot-water supply or for heating a house. The heat can also be used directly to drive heat engines or to obtain electric power through thermocouples. Effectiveness for these last two applications depends largely on the temperature of the flat-plate collector.

The higher the temperature of the plates of the collector, the greater the temperature difference which the heat engine or thermocouple has available for its operation. However, the hotter the plate the larger are the losses to the surroundings due to radiation and convection. To cut down these losses the boxes containing the absorber plates are often glassed in, with one or more glass layers between the absorbing plate and the sun. This cuts down sharply on convection losses and on radiation losses as well, for although glass transmits the short visible wavelengths in which most of the incident solar energy is concentrated, it is a poor transmitter for the longer wavelengths at which the heated black plate emits most of its radiation. Of course the

more layers of glass used, the greater are these effects, but the losses due to transmission and reflection of sunlight through the extra glass layers also increase. Two or three glass layers seem to be the best compromise, but of course the use of these layers adds to the cost of the installation.

At the recent meeting in Tucson a new approach to this problem was proposed by Professor Tabor of the National Physical Laboratory of Israel. Professor Tabor has used flat-plate absorbers covered with a thin layer of finely divided metal and has succeeded in producing plates that are good absorbers of sunlight but which re-radiate very little energy. Professor Tabor makes use of the fact that the energy of the incoming sunlight is almost all in wavelengths shorter than 2 microns while the energy re-emitted by the collector plates, even when at temperatures of 300°C, is almost all in longer wavelengths. Professor Tabor's plates are good short-wavelength absorbers and poor long-wavelength emitters, and therefore absorb the sunlight and re-emit very little energy. These desirable absorbing and emitting characteristics are obtained by coating the metal plates with a deposit of smoke or finely divided metal powder, which appears black to the eye.

Professor Tabor has computed the effect of using these selectively absorbing blacks on a flat-plate receiver with one cover glass. The receiver is assumed to be working in the sunlight of the Jerusalem area and the heat is used to drive an ideal Carnot heat engine. Using selectively absorbing blacks an efficiency of 8 percent results as compared to 4-percent efficiency with an ordinary collector. Also, since radiation loss has been reduced, convection loss is now more important, so if the space between the glass cover and the plate is partially evacuated, a 13.9-percent efficiency is obtained as compared to a 5-percent figure for an ordinary collector. Since this efficiency measures the percent of the total incident radiation converted into mechanical work, it is clear that the use of selectively absorbing blacks may represent a considerable advance in methods of using solar energy.

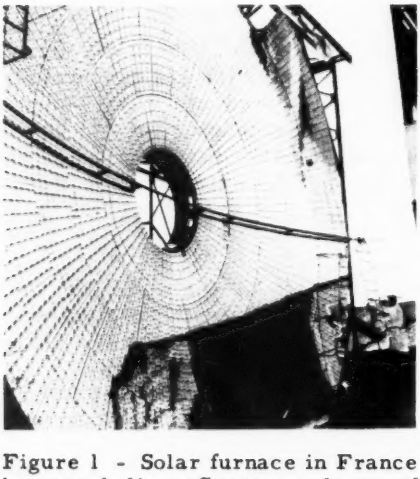


Figure 1 - Solar furnace in France has parabolic reflector made up of 3500 small mirrors. *(Photo by University of Wisconsin Photographic Laboratory)*

A very different application of solar energy is the high-temperature solar furnace. A solar furnace is simply a parabolic reflector which focusses the incoming sunlight into a single point. The largest such furnace in the world today is at the Laboratoire de L'Energie Solaire at Mont-Louis, France. This reflector (Figure 1) is made up of 3500 small, curved mirrors and has a diameter of 10.8 meters, a focal length of 6 meters, and is set on a fixed mounting. A large flat mirror moves with

the sun and reflects sunlight into the parabolic mirror which concentrates the energy into a focal spot about 10 cm in diameter. A crucible charged with material is placed at the focal spot with focussed radiation coming through the open end (Figure 2). Temperatures up to 3000°C can be obtained and quite large lots of refractory materials can be treated.

The stabilization of zirconium oxide is an example of the sort of thing that can be accomplished with the solar furnace. In spite of its high melting point (2600°C) zirconium oxide has been of limited utility as a refractory material because it undergoes a crystalline change of state accompanied by a change of volume at about 1100°C. This change of volume has been enough to crack ceramic objects made of the oxide. If 4 percent of quicklime is mixed with the powdered oxide and the

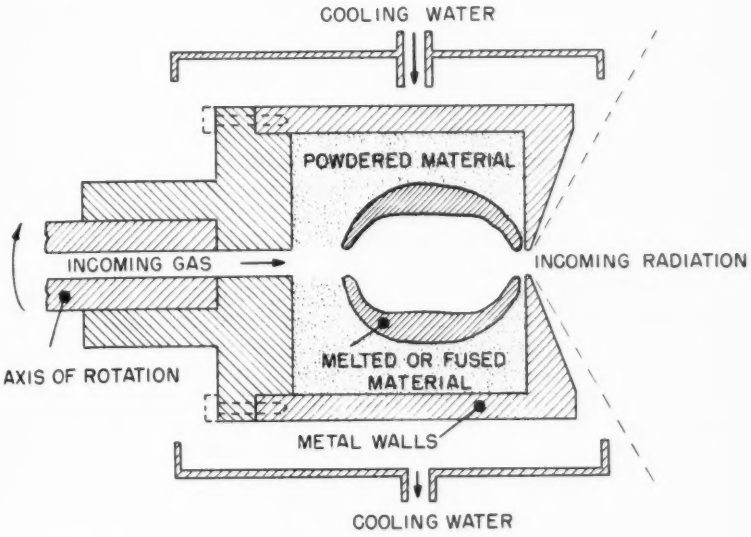


Figure 2 - A typical crucible.

mixture is fused at 2600°C in the solar furnace, a material results with a cubic structure which remains stable at all temperatures. The huge solar furnace at Mont-Louis is capable of preparing this material in 50-kilogram lots, and more than three tons have already been made and sold for use as a refractory material in industry.

A further advantage of the solar furnace is that the material can be treated without contamination from the crucible. This is clear from Figure 2, where the melted material is seen to be in contact with the unmelted powdered material rather than with the crucible. The crucible is usually spun about an axis, as shown in Figure 2. This has the advantage that centrifugal force keeps both the melted material and any vapor emitted flattened against the walls and maintains a cavity

approximating a blackbody.* By admitting gas into the cavity through the hollow axis of rotation, materials can be treated in a variety of atmospheres.

One of the more spectacular recent developments in using solar energy has been the development of the solar battery. Modern semiconductor techniques have led to the development of materials (usually germanium or silicon crystals with impurities added) which when illuminated send a small current through a wire connected across the crystal ends. Carefully prepared laboratory cells have been able to convert 10 percent of the incident sunlight into electrical energy, and the theoretical limit to the performance of these cells is thought to be about 22 percent. These cells, which can produce a few milliwatts per square centimeter of sunlit surface, are a convenient source of small amounts of power, but at the present time are too expensive to be used as a major power source.

Along a different line are experiments conducted in this country by Arthur D. Little, and in Japan by the Tokugawa Institute for Biological Research on the growth of algae, especially Chlorella, for fuel or food. The algae require nothing but sun and water for their growth, and when powdered make a nourishing food. If the expense of growing them can be reduced, algae may become an important food supplement, especially in the Orient, since the appearance of the powdered algae is not markedly different from that of some conventional Eastern foods.

There is a variety of other uses for solar energy. Reflectors can be used for cooking, and sunlight is clearly a convenient source of energy for evaporating sea water, for irrigation, or for power for small isolated settlements. However, how widely solar energy will be used will depend on its economics. As compared to conventional power sources, power from solar energy usually requires a large initial investment, then very little further expense. Whether it is competitive with ordinary power sources depends on the sunlight conditions of the region being considered and on the cost of conventional fuels. It is not generally competitive in the United States, but it may be in some of the more arid underdeveloped areas.

Solar energy has the advantage compared with fossil fuels that it conserves the dwindling supply of coal and oil. This is a desirable feature it shares with atomic energy. Compared with atomic energy, however, it has the advantage that it can come in small packages and is not plagued by the problem of disposing of radioactive wastes. One guess as to the future would be that solar energy will be used for smaller units, atomic energy for main power stations. However, it is hard to predict the progress that large-scale research may make in a field that until now has been the preserve of a few isolated solar-energy enthusiasts.

---

*A blackbody is defined as a surface which absorbs all radiation incident upon it. A perfect blackbody does not exist.

Research Notes

Motion Picture on Naval Medical Research

The Bureau of Medicine and Surgery has recently issued a color motion picture survey of the current status of the medical research program in naval laboratories. The subject matter of the film is presented at a professional level for medical officers and others engaged in medical research or on duty in other capacities with the naval medical department. However, one does not have to have a medical background to follow the explanations and descriptions of the medical investigations that are dramatically presented in the film. The color picture brings out the broad scope of the naval medical research program, its organization, its objectives, and shows some of the typical projects underway in each of its main phases.

In the first part of the film, well-planned sequences deal with Navy laboratory research in the field of general medicine and surgery. Some of the studies are broad in scope; a good example is the one which records changes in weight as experienced by recruits during the weeks of boot training.

A highlight of that part of the film dealing with communicable and infectious diseases concerns the effort made to control insect-borne diseases by a single massive application of an insecticide. The photographers were able to get extremely graphic pictures on the ovipository reaction of an insect during its death throes.

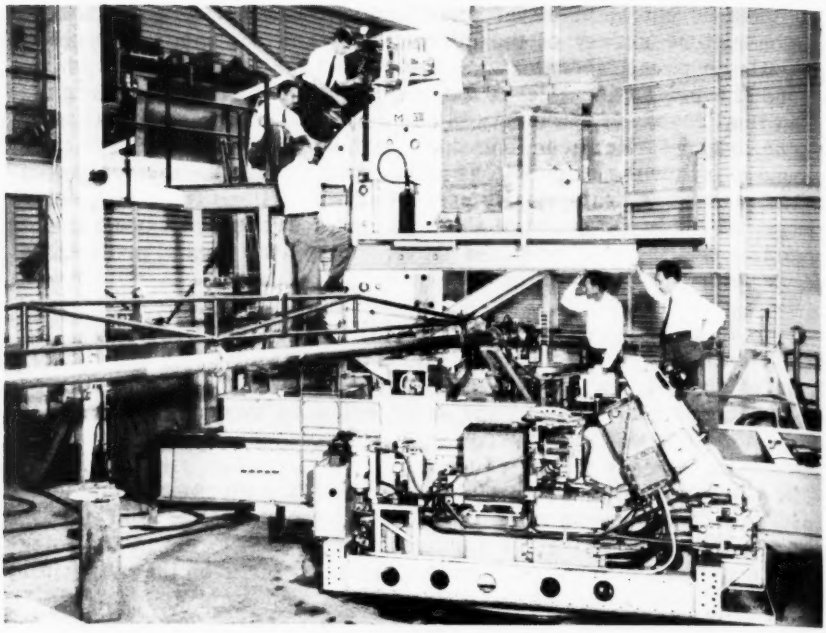
The second part of the film describes medical research more directly related to environmental stresses and hazards within the naval service. Attention has been given to both combat readiness and combat effectiveness. One sequence deals with submarine service, and the efforts of scientists to determine safe tolerance levels of carbon dioxide in prolonged submerged operations. Another phase is concerned with the apparently simple problem of, "What is the best color for the Navy's survival equipment?" The investigative process by which researchers found the answer is unfolded as the film proceeds.

At the end, there is a quick rundown or summary of the various research activities covered in the 52 minutes of color film. The motion picture was made in two equal sections, and each has a number and title:

MN-7929a Naval Medical Research—A Survey (Part 1)
MN-7929b Naval Medical Research—A Survey (Part 2)

Each U. S. Naval Hospital and naval medical research facility has been sent a distribution print of the film. Other naval activities, if interested, may arrange short-term loans with the nearest Navy unit furnished with a print. Non-naval activities, including civilian organizations, may borrow the film on a short-term basis through the Bureau of Medicine and Surgery (Code 3163), Department of the Navy, Washington, D.C. Requests for loans should mention the film by its official number and title, the date and two alternate dates on which the activity desires to show the film and the estimated number of people who will attend.

Stanford's 550-MEV Accelerator



In the photo above, Stanford University scientists are making final adjustments to the 55-ton "eye piece" of their recently completed nuclear microscope. Though the device does not enable them to actually see the nuclear particles, it measures nuclear dimensions with an accuracy of four-thousandths of a trillionth of an inch, and is revealing more information about the atom's core than man has ever known. The long pipe at left leads from Stanford's 220-foot electron linear accelerator, which supplies the 550,000,000-volt electrons that probe atomic nuclei of the material under scrutiny (in this case, the nuclei of a gold foil mounted in the ladder-like frame at end of pipe). Physics Professor Robert Hofstadter (right) directs the research project, which is sponsored by the Office of Naval Research, the Atomic Energy Commission, and the Air Force. Others are (from top) Jerome H. Fregeau, Lance Rogers, F. W. Bunker, and Robert Keith.

The Age of Icebergs

It could well be, according to recent scientific findings, that icebergs which are a hazard in North Atlantic shipping lanes, may be a million years old. Such was the opinion of three scientists who have been making special studies on the age of icebergs found near the Labrador coast. They test the oxygen content of gas bubbles trapped in the ice. They are aboard the research vessel, BLUE DOLPHIN, which is on a scientific expedition sent out by the Arctic Institute of North America but with the support of funds provided by the Office of Naval Research.

Low-Cost Detector Measures Fallout

The fallout from an atomic or nuclear incident has for some months been a topic of lively discussion. Not infrequently the question has been posed, "How can we know about this fallout—how can we measure it?" An instrument recently developed at the Naval Research Laboratory provides an answer to this question. It gives positive indication of both the presence and the amount of fallout.

The new device is small, simple to operate, uses commercially available components, and lends itself to low-cost, mass production. As for possible use, it is practical to distribute generally as an item anyone can buy, or it can be a highly useful instrument assigned to Civil Defense monitor teams.

The meter makes use of a crystal—cadmium sulphide—in the actual detection of the gamma radiation. This radiation, when present, causes the crystal to produce an electrical current which charges a capacitor. When the capacitor is fully charged, it discharges and lights a neon lamp. The lamp flashes on and off as the capacitor charges and discharges. The rate of flashing is an indication of the intensity of the radiation present.

The new instrument will detect gamma radiation over a wide range: from 0.1 to 1000 roentgens per hour. A roentgen is a standard measurement of quantity or "dose" of radiation; a lethal dose is generally considered to be between 300 and 600 roentgens). Scientists at NRL have been studying the effects of radiation on crystalline materials since 1947. This newest detector logically follows others such as the "dog tag" locket-type already widely in use for military personnel.

Scientific Personnel Resources

A report recently issued by the National Science Foundation carried the title "Scientific Personnel Resources," and brings up to date the information found in other previous reports on the subject. The supply, utilization, and training of scientists and engineers are summarized in various ways. Figures are given, for instance, on the distribution of scientific personnel resources, by field of activity, age, and level of education. This information is drawn from tabulated data on 200,000 scientists and 650,000 engineers in the United States.

The shortage of science and mathematics teachers was pointed up by the statistics on the number of college graduates seeking a career in these particular branches of teaching. Future teachers who took steps to meet standard requirements for assignments in science and mathematics were considerably less in number than the future teachers of only four years ago. The decrease in science teachers was from 9000 to 4000; in mathematics teachers, from 4000 to 2300.

The full report is available from the Superintendent of Documents, Washington 25, D.C. for 50 cents.

On the Naval Research Reserve

New Companies Activated

The December issue of Research Reviews reported the activation of the one hundredth Reserve Research Company. The activation of NRRC 3-11, Ithaca, N. Y. on 27 October 1955 marked this milestone. Three more companies have since been established, and several others are scheduled for the near future. At each initial meeting, Captain Theodore Blanchard, USNR, Special Assistant to the Chief of Naval Research, has been present to read the activation orders.

On 13 December 1955, NRRC 3-12, New London, Conn., was formally activated, with LCDR J. A. Wheeler, USNR, as Commanding Officer. The charter membership of the Company is made up of employees of the Electric Boat Company (eight officers), the Navy Underwater Sound Laboratory (five officers), and one officer each from the Robert Gair Co. and the Dow Chemical Co. (Picture, inside back cover)

Naval Reserve Research Company 4-11, Cincinnati, Ohio, was officially activated 8 December 1955, on the campus of Xavier University. Prior to activation as a company, most of the members of NRRC 4-11 had been affiliated with the Research Reserve as members of a panel operating under NRRC 4-9, Dayton, Ohio. LCDR Edwin Gud, USNR, is Commanding Officer of the new company. (Picture, inside back cover)

Naval Reserve Research Company 5-1, Hampton, Virginia, was officially activated by the Commandant, Fifth Naval District, effective 1 January 1956. The new Commanding Officer is LT(JG) J. C. Dunavant, USNR. NRRC 5-1 is actually the eighth company to be activated in the Fifth Naval District, but it has been designated 5-1 because a group organized in the early stages of the program has since been deactivated.

Research Reservists at Willow Grove, Pa., who have previously operated as a panel under NRRC 4-2, Philadelphia, were formally activated as a company on 14 February. LT Lewis H. Smith, USNR is Commanding Officer of this company, designated NRRC 4-12.

In addition to the companies already formed, several new groups are in the organizational stage, with activation meetings scheduled. NRRC 6-17, Huntsville, Ala., is scheduled for an activation ceremony on 20 March 1956. This company has been officially established as of 2 February 1956. LT H. F. Thames, USNR, will be the Commanding Officer. NRRC 6-18, Nashville, Tenn., will hold its activation meeting on 4 May 1956. This company, which will be headed by CDR G. B. Sudduth, USNR, will have official status as of 2 April.

Out in California, the Commandant, Eleventh Naval District, has requested authority from the Chief of Naval Personnel to activate two new companies. Naval Reserve Research Company 11-8, at the Naval Air Missile Test Center, Port Mugu, California, has an activation date of 1 April 1956; NRRC 11-9, at Aero-jet General Corporation, Azusa, California, is set for establishment on the same date.

Urbana Company Commended

NRRC 9-2, of Urbana, Illinois, went to the top in 1955 as the outstanding Research Reserve Company in the Ninth Naval District. Captain James E. Cohn, USN, Commanding Officer of ONR-Chicago, presented the letter of Commendation to CDR Charles H. Boman, USNR, former Commanding Officer of the unit, at the 31 January meeting.

Nine Dash Two's success was due, in no small measure, to the excellent "Study Course Guide for the Naval Reserve Research Program" which was completed as a company project. The program and its authors have been officially commended by the Chief of Naval Research; a topical listing of the courses is included in the next item, below.

The presentation ceremony was made the occasion for a reception and dinner. The guest list included CAPT J. M. Lane, USN, Professor of Naval Science, NROTC, University of Illinois, and his Executive Officer, CDR W. S. Bradway, Jr., USN, LCDR H. T. Wordell, Research Program Officer, ONR-Chicago, Mr. John Richardson, Head, Contract Administration Department, ONR-Chicago, and Mr. F.X. Finnegan, ONR Resident Representative, Urbana.

Curriculum

The Study Course Outline, prepared by NRRC 9-2 as a company project, has been approved, and the assembly of supporting reference material is being accomplished. A reference volume for use by instructors will be provided to accompany the course outline. It is expected that the complete package will be available to the local companies by 1 July 1956. Availability of supporting films and other training aids is also being investigated. The course outline, designed to establish greater familiarity with the Office of Naval Research and its associated activities, consists of fifteen lesson plans, each of which will provide material for one company meeting.

The course outline will be made available to the local companies for voluntary and flexible inclusion in their training schedules. After the first four units have been scheduled, the remaining lessons may follow in any order. The breakdown of lesson subjects is as follows:

1. Research and Development in the Department of Defense
2. Organization of the Office of Naval Research
3. Organization of the Research Group of ONR
4. Relationship of ONR to other Research and Development activities of Government
5. Operational Methods of ONR
6. Technical Information Dissemination
7. Indirect Research Activities of ONR
8. Naval Research Laboratory
9. Special Devices Center
10. Underwater Sound Reference Laboratory
11. ONR Contractual Methods
12. Contract Administration in the Residency
13. Security in the Office of Naval Research
14. Naval Reserve Program of ONR I
15. Naval Reserve Program of ONR II

Complete lesson packages on the Naval Research Laboratory, the Underwater Sound Reference Laboratory, and the Special Devices Center are being prepared by the respective NRR companies that meet at those institutions.

New Projects Undertaken

Within the past several months, a number of Research Reserve Projects have been approved under the authority granted by BuPers Instruction 3920.2 and through the procedures established by ONR Instruction 3920.2. For instance, NRRC 4-4, University Park, Pa., has a company project approved on the "Analysis of Closed Circuit TV as a Training Medium" and Company 4-4 has previously completed an "Analysis of Training Films." A report of the latter project has been made available to a number of training activities and has been favorably received.

NRRC 12-8, Monterey, California, is at work on a Course Outline for Logistics, similar to the one on the Office of Naval Research prepared by the Urbana group. NRRC 9-16, East Lansing, Mich., is also working on course material on logistics. The overall-curriculum plans for the Research Reserve call for courses in operations and in administration. Project proposals from groups desiring to work in these areas are encouraged.

Two members of NRRC 8-4, Houston, Texas, have been recommended for Appropriate Duty Orders to perform a project on "The Use of Existing TV - Kinescope Facilities for Emergency Facsimile Transmission of Dispatches." LCDR J. W. Meaney, USNR, and ENS Richard Uray, USNR, will work on this project. CDR Eugene P. Cronkite, USNR, and LCDR Victor P. Bond, USNR, of NRRC 3-9, Brookhaven, N. Y., have received ONR approval on a request to perform appropriate duty on a project concerned with radiation injury from fallout material.

The project program for the Research Reserve is designed to afford qualified members an opportunity to contribute their talent and time to the solution of current problems. Projects submitted and approved under the directives mentioned above, whether they are performed as company undertakings or by individuals on appropriate duty, have the official status both to give the members credit for the investigations performed and to provide the distribution of reports required for review by appropriate naval activities.

Reserve Program Officers Conference

A Program Officers Conference was held at ONR, Washington, during the period 24-26 January 1956. CAPT Theodore Blanchard, Special Assistant for Reserve, was conference chairman. He was assisted by CDR H. F. Burr, Training Officer, and Mr. W. P. Warren, Administrative Assistant, in leading the discussions listed on the agenda. Those attending included program officers from various Naval Districts and from the branch offices of ONR. In the main, the discussions related to recruiting, training, and mobilization, as well as other developments of interest to the Research Reserve. At one point in the conference, CDR D. N. Morey, Jr., Head Special Program Branch, BuPers, discussed the current situation with respect to the Naval Reserve in general.

U.S. GOVERNMENT PRINTING OFFICE : 1956 O - 376852

New Research Companies

NRRC 3-12 at New London, LCDR J. A. Wheeler, commanding

NRRC 4-11 at Cincinnati, LCDR Edwin Gud, commanding

Think it Over—

you now

have four years

toward young retirement

GET ALL THE FACTS TO GUIDE YOUR FUTURE